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ORIGINAL RESEARCH

Accuracy of Pain Scales in Predicting Critical Diagnoses in Non-Traumatic Abdominal Pain Cases; a Cross-sectional Study

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Abstract: **Introduction:** Accurate assessment and management of abdominal pain in the emergency department (ED) is crucial, as it can indicate potentially life-threatening conditions requiring timely treatment. This study aimed to evaluate the ability of pain scales to predict critical diagnoses in patients with non-traumatic abdominal pain. **Methods:** This cross-sectional study was conducted at a tertiary university hospital and involved individuals aged 15 years and above who presented to the ED with non-traumatic abdominal pain. Pain severity was evaluated using subjective pain scales, including the Numerical Rating Scale (NRS) and the Face Pain Scale (FPS), as well as objective pain scales, including the Critical Care Pain Observation Tool (CPOT) and the Non-verbal Pain Score (NVPS). The area under the receiver operating characteristic curve (AuROC) was employed to determine the discriminative ability of each pain scale to predict critical diagnosis. **Results:** 264 cases with the mean age of 47.2±19.4 years were studied (53.0% male). The most common location of abdominal pain was epigastric pain (43.9%). Most patients presented with dull-aching pain, and those with critical diagnoses had more of this characteristic than those with non-critical diagnoses. (52.5% vs. 28.3%, p = 0.01). The overall median NRS, FPS, CPOT, and NVPS of included participants were 8 (interquartile range (IQR) 7-10), 8 (IQR 6-8), 3 (IQR 1-4), and 3 (IQR 2-4), respectively. Patients with critical diagnoses had a higher NVPS score than patients with non-critical diagnoses (median score of 4 vs. 3, p = 0.02). The AuROC of NRS, FPS, CPOT, and NVPS were 0.53 (95% CI: 0.45-0.62), 0.55 (95% CI: 0.46-0.63), 0.59 (95% CI: 0.50-0.68), and 0.62 (95% CI: 0.53-0.71), respectively. The correlation coefficients among these scales were considered moderately correlated or higher. **Conclusion:** In evaluating patients with non-traumatic abdominal pain, the NVPS demonstrated the highest accuracy in predicting critical diagnoses. However, all pain scales, whether subjective or objective, exhibited suboptimal performance in predicting critical diagnoses.

Keywords: Abdominal pain; pain management; pain scale; pain severity; numerical rating scale; critical care pain observation tool

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1. Introduction

Abdominal pain represents one of the most common chief complaints in the emergency department (ED), especially for those with high pain severity, and accounts for about 5-10% of total ED visits (1-4). The causes and severity of abdominal pain vary in the literature (3). patients presenting with abdominal pain but varying in age may have different diagnoses, treatments, morbidities, and mortalities (1, 4). Pain typically results from tissue injury (5). The perception of and reaction to pain generates a wide spectrum in the general population since it does not depend only on the cause of pain but also on psychological, physiological, emotional, and behavioral dimensions (6).

It is important to accurately assess and manage abdomi-

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nal pain in the ED, as it can be a symptom of many conditions, some of which may be life-threatening if not treated promptly. Subjective pain scales, such as the Numeric Rating Scale (NRS) and the Face Pain Scale (FPS), are commonly used to assess pain in patients who verbalize pain (7-14). However, critically ill patients may be unable to communicate their pains, so objective pain assessment tools such as the Critical Care Pain Observation Tool (CPOT) and the Non-verbal Pain Score (NVPS) have been developed to assess pain in these patients based on clinical observations (15-19). There is evidence suggesting that subjective pain scales may not be as reliable or valid as objective pain scales in certain settings, such as in developing countries or critically ill patients (20).

However, the relationship between subjective and objective pain scales and their abilities to predict critical diagnoses in patients with non-traumatic abdominal pain has not been extensively studied.

Our hypothesis is that subjective and objective pain scales may rate the severity of abdominal pain differently, with the objective pain scale showing more severe diagnoses. Gaining insight into these relationships would aid clinicians in appropriately managing patients and mitigating potential biases that could arise from the traditional use of subjective pain scales. This study aims to investigate the accuracy of different pain scales in predicting critical diagnoses in patients presenting to ED with non-traumatic abdominal pain.

2. Methods

2.1. Study design and setting

This prospective observational study was conducted at the ED, Maharaj Nakorn Chiang Mai Hospital, a tertiary university hospital, between November 2021 and October 2022. The pain score of patients with non-traumatic abdominal pain were calculated using different scoring systems and the accuracy of each system in identifying patients with critical diagnosis was evaluated. The ED's triage classification is based on a five-level system, according to the Canadian Triage and Acuity Scale, with level 1 being the most urgent (resuscitation) and level 5 being the least urgent (non-urgency). Our study was performed following the Declaration of Helsinki statements. A local ethics committee's approval has been obtained (EME-2564-08371), and all enrolled patients have signed consent forms.

2.2. Participants

Individuals older than 15 years who presented with non-traumatic abdominal pain were included in this study. Patients who received definite diagnoses and treatments before arrival, those who were pregnant, and those with poor communication were excluded. This study was prepared and reported according to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement (21).

2.3. Data gathering and data collection

Pain assessment was conducted at the triage area when the patient first presented to the ED. Assessors had experience working in the ED for at least 3 years, and they were trained and standardized before participating in this research.

Assessors evaluated and recorded the pain severity scores using the respective scales. The assessment process typically took 1-2 minutes and did not interfere with the routine care process. The physiological parameters used in the NVPS, such as blood pressure, heart rate, and respiratory rate, were measured using standard medical equipment. The baseline characteristics of patients as well as their pain scores based on 4 studied systems were collected from the patients' charts. The relevant data were selected and entered into REDcap (Vanderbilt University, Nashville, TN, USA) at the same time. Specifically, we collected sex, ethnicity, day and time of arrival, location, characteristics, and duration of pain, and related vital signs.

2.4. Numerical Rating Scale

The 0-10 NRS employs 11 numbers (0 through 10) for assessing pain intensity (22). Participants were guided to choose the number that most accurately represented their pain level, with 0 indicating the absence of pain and 10 indicating the most severe pain. We opted for this scale due to its widespread clinical use and established reliability and validity to measure pain intensity.

2.5. Face Pain Scale

The FPS consists of eleven line-drawn faces presented in a horizontal format, characterizing no pain to worst pain (23). Participants were asked to indicate the facial expression that most accurately conveyed the level of pain they were experiencing. The choice of the FPS over alternative options was based on several considerations: the facial representations were perceived as less childlike, the absence of tears helped mitigate potential cultural biases regarding pain expression, and a neutral face was employed to signify the absence of pain instead of a happy face.

2.6. Critical Care Pain Observation Tool

The CPOT is an objective pain scale that assesses pain based on four behavioral criteria: facial expression, body movement, muscle tension, and vocalization (24). Its total score ranges from 0 to 8, with higher scores indicating more severe pain. We included this score since it has been validated for assessing pain in non-verbal critically ill patients (25).

2.7. Non-Verbal Pain Score

The NVPS is another objective pain scale that assesses pain based on five indicators: face, activity, body activity, guarding, and physiology (including vital signs and respiratory status) (26). The scores for each of the five NVPS components are summed for a total score of 0-10. This score was included since it is considered easy to use and is likely applicable more than other behavior-based pain assessment tools (27).

2.8. Outcomes

The primary outcome was being diagnosed with critical diagnoses, defined as the disease having the potential to cause life-threatening conditions. The diseases included acute intestinal obstruction, visceral perforation, acute pancreatitis, mesenteric ischemia, ruptured abdominal aortic aneurysm, ruptured ectopic pregnancy, myocardial infarction, intra-abdominal infection and bleeding, and anaphylaxis (4, 28-31). Diagnoses were made by physicians on duty at the ED and confirmed by the others by reviewing the chart. Secondary outcomes included the rate of hospital admission obtained by chart review. Complete case analysis approach was employed to handle the missing data. All patients underwent the investigations and treatments according to the standard of care.

2.9. Statistical analysis

Based on the previous study (15), sample size was estimated at least 262 patients to achieve a two-sided alpha error of 0.05 and 80% statistical power (32). All Analyses were performed using STATA/MP software version 16.1. Qualitative data were presented numerically and by percentage. Quantitative variables were presented using means with standard deviations or medians with interquartile ranges (IQRs), as appropriate. Chi-square and Fisher's exact tests were used to compare categorical variables, whereas independent t-tests and Wilcoxon rank-sum tests were used to compare continuous variables. Using the receiver operating characteristic (ROC) curve, the accuracy of NRS, FPS, CCOT, and NVPS in predicting critical diagnosis in patients presenting to the ED with non-traumatic abdominal pain was evaluated.

Spearman's rank correlation coefficients were calculated to determine the relationship between each pain scale. A p-value less than 0.05 was considered statistically significant.

3. Results

3.1. Baseline characteristics of studied cases

Of the 11,897 adults who presented to the ED with non-traumatic complaints, 264 were included in the analysis. Figure 1 illustrates the study flow diagram. The mean age of the included participants was 47.2 ± 19.4 (range: 15-94) years (53.0% male). 92.1% of cases were Thai and 51.3% came to ED during the evening shift. The most common location of abdominal pain was epigastric pain (43.9%). Most patients presented with dull-aching pain, and those with critical diagnoses had more of this characteristic than those with non-critical diagnoses. (52.5% vs. 28.3%, p = 0.01). The average respiratory rate was 19.8±3.3 per minute, and patients with critical diagnoses had a faster respiratory rate than patients with non-critical diagnoses (p = 0.002). The baseline characteristics of the included patients are shown in Table 1.

3.2. Accuracy of pain scores in predicting the critical cases

The overall median NRS, FPS, CPOT, and NVPS of included participants were 8 (IQR 7-10), 8 (IQR 6-8), 3 (IQR 1-4), and 3 (IQR 2-4), respectively. The patients with critical diagnoses had a higher NVPS score than patients with non-critical diagnoses (median score of 4 vs. 3, p = 0.02). No pain scales were significantly associated with risk stratification of hospital admission. Each pain scale, including subjective and objective pain scales, and their associations with being diagnosed with critical diseases and hospital admission were summarized in Table 2.

The correlation between NRS and FPS was 0.656 (0.581–0.719), and between CPOT and NVPS was 0.818. The correlation between the scores in the same category was higher than in the different categories, and the correlation between CPOT and NVPS was the highest (Table 3). Figure 2 illustrates the ROC curves of each scale for predicting the patients presenting to the ED with non-traumatic critical abdominal pain. These scales were considered unsatisfactory based on the area under the ROC curve (AuROC) except for NVPS, which had the highest AuROC (0.62, 95% CI: 0.53-0.71).

4. Discussion

This study highlights that the NVPS exhibited the highest accuracy in predicting critical diagnoses among patients with non-traumatic abdominal pain, with an AuROC of 0.62. Nevertheless, overall, the performance of all scales in predicting critical diagnoses was suboptimal. Additionally, we observed that there was a significant correlation between pain scales, with stronger correlations seen within the same category of pain scales (subjective or objective) compared to those between different categories.

Effective pain assessment is important for providing patients with high-quality care, especially in the ED (9). Subjective pain scales rely on patients' self-report of pain intensity (18), and while these scales are generally considered reliable and valid, they can be influenced by various factors, including patient expectations, anxiety, and prior experiences

(33, 34). It has been demonstrated that patients suffering from non-specific abdominal pain had higher self-reported pain scores than those suffering from a bowel obstruction (35). This evidence supported the notion that self-reported pain scales were likely ineffective in assessing patients. In contrast, objective pain scales, which rely on physiological and behavioral measures, may be less influenced by patient-related factors but might be less sensitive to individual differences in pain perception (36, 37). Similar to the previous study (38), our findings demonstrated that all pain scales showed good correlation coefficients, suggesting that each scale could serve as a reasonable proxy for assessing pain severity.

Pain can be produced by several mechanisms along four major pathways (pain detection, pain transmission, pain modulation, and pain expression). It can be responded to by two reflexes: the autonomic and endocrine responses (39). Autonomic response to pain caused physiological changes, so these parameters were used in the objective pain scales. Previous research has primarily explored the accuracy of objective pain assessments, including CPOT and NVPS, in the context of the intensive care unit and among critically ill patients (40-43). These studies generally found these scores to have some feasibility and validity for potential application in clinical practice. Consistent with our findings, NVPS, which takes into account physiological indicators (i.e., blood pressure, heart rate, and respiratory rate) exhibited the highest AuROC value among the various pain scales. However, it is important to emphasize that none of the pain scales exhibited robust predictive capabilities for critical diagnoses. Objective pain scales appeared to be more responsive to changes in pain intensity over time since they don't rely on patient self-reports. Nevertheless, it is worth noting that objective pain scales may be less reliable in specific patient groups, such as those using antihypertensive medications or within certain age groups.

Our study is the first to evaluate both subjective and objective pain scales for predicting critical diagnoses in patients with non-traumatic abdominal pain in the ED. This investigation sheds light on the potential advantages of objective pain scales and physiological parameters in assessing abdominal pain in emergency care settings. However, it is crucial to recognize that patients with non-traumatic abdominal pain present with a diverse range of underlying conditions, including gastrointestinal, genitourinary, and cardiovascular diseases (10). These distinct pathophysiologies may influence how patients perceive and report their pain. Consequently, future research should delve into the associations between pain scales and specific life-threatening diseases.

5. Limitations

Our findings should be viewed in light of certain limitations. We selected a specific set of pain scales for evaluation, which may not represent the full spectrum of available pain assessment tools. Our study focused exclusively on non-traumatic abdominal pain, and the generalization of our results to other types of pain or healthcare settings should be approached with caution. To enhance the external validity of our findings, further research should aim to replicate our study in diverse clinical settings and patient populations. Conducting multi-center studies or investigations in different geographic regions can help determine the extent to which our results can be generalized. Moreover, future research should consider the impact of variations in clinical practice, healthcare resources, and patient characteristics on the performance of pain assessment tools. Additionally, some patients did not undergo complete gold-standard investigations, which may introduce bias into the accuracy of diagnoses. Furthermore, our study was conducted at a single university hospital, and its findings may not be generalizable to other healthcare settings. Finally, the composite outcome of being diagnosed with critical abdominal conditions, while informative, may not be directly translatable to individual diseases, which may have distinct clinical presentations.

6. Conclusion

In evaluating patients with non-traumatic abdominal pain, the NVPS demonstrated the highest accuracy in predicting critical diagnoses. However, all pain scales, whether subjective or objective, exhibited suboptimal performance in predicting critical diagnoses.

7. Declarations

7.1. Acknowledgments

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7.2. Conflict of interest disclosure

The authors declare no conflict of interest.

7.3. Funding statement

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7.4. Authors' contribution

Conceptualization: Supapilai Ueareekul, Chanon Changratanakorn, Parinya Tianwibool, Nattikarn Meelarp, and Wachira Wongtanasarasin; Methodology: Supapilai Ueareekul, Chanon Changratanakorn, Parinya Tianwibool, Nattikarn Meelarp, and Wachira Wongtanasarasin; Software: Supapilai Ueareekul and Wachira Wongtanasarasin; Validation: Supapilai Ueareekul and Wachira Wongtanasarasin; Formal analysis: Wachira Wongtanasarasin; Investigation: Supapilai Ueareekul and Wachira Wongtanasarasin; Data curation: Supapilai Ueareekul and Wachira Wongtanasarasin; Original draft: Supapilai Ueareekul and Wachira Wongtanasarasin; Writing – Review and editing: Wachira Wongtanasarasin; Funding acquisition: Wachira Wongtanasarasin. All authors read and approved the final version of manuscript.

7.5. Ethics approval statement

Our study was performed following the Declaration of Helsinki statements. A local ethics committee's approval has been obtained (EME-2564-08371), and all enrolled patients have signed consent forms.

7.6. Data availability

The datasets generated and analyzed during the current study are available from the corresponding author on reasonable request.

7.7. Using artificial intelligence chatbots

None.

References

1. Magidson PD, Martinez JP. Abdominal pain in the geriatric patient. Emerg Med Clin North Am. 2016;34(3):559-74.
2. Caporale N, Morselli-Labate AM, Nardi E, Cogliandro R, Cavazza M, Stanghellini V. Acute abdominal pain in the emergency department of a university hospital in Italy. United European Gastroenterol J. 2016;4(2):297-304.
3. Chanana L, Jegaraj MA, Kalyaniwala K, Yadav B, Abilash K. Clinical profile of non-traumatic acute abdominal pain presenting to an adult emergency department. J Family Med Prim Care. 2015;4(3):422.
4. Takayama Y, Kaneoka Y, Maeda A, Fukami Y, Takahashi T, Uji M. Etiologies and outcomes of emergency surgery for acute abdominal pain: an audit of 1456 cases in a single center. Eur J Trauma Emerg Surg. 2020;46(2):363-9.
5. Dinakar P, Stillman AM. Pathogenesis of pain. Semin Pediatr Neurol. 2016;23(3):201-8.
6. Linton SJ, Shaw WS. Impact of psychological factors in the experience of pain. Phys Ther. 2011;91(5):700-11.
7. Williamson A, Hoggart B. Pain: a review of three commonly used pain rating scales. J Clin Nurs. 2005;14(7):798-804.
8. Hjermstad MJ, Fayers PM, Haugen DF, Caraceni A, Hanks GW, Loge JH, et al. Studies comparing numerical rating scales, verbal rating scales, and visual analogue scales for assessment of pain intensity in adults: a systematic literature review. J Pain Symptom Manage. 2011;41(6):1073-93.
9. Todd KH. Pain assessment instruments for use in the emergency department. Emerg Med Clin North Am. 2005;23(2):285-95.
10. Daoust R, Beaulieu P, Manzini C, Chauny J-M, Lavigne G. Estimation of pain intensity in emergency medicine: a validation study. Pain. 2008;138(3):565-70.
11. Lee J. Pain measurement: understanding existing tools and their application in the emergency department. Emerg Med (Fremantle). 2001;13(3):279-87.
12. Pathak A, Sharma S, Jensen MP. The utility and validity of pain intensity rating scales for use in developing countries. Pain rep. 2018;3(5):e672.
13. Mohan H, Ryan J, Whelan B, Wakai A. The end of the line? The Visual Analogue Scale and Verbal Numerical Rating Scale as pain assessment tools in the emergency department. Emerg Med J. 2010;27(5):372-5.
14. Thong IS, Jensen MP, Miró J, Tan G. The validity of pain intensity measures: what do the NRS, VAS, VRS, and FPS-R measure? Scand J Pain 2018;18(1):99-107.
15. Severgnini P, Pelosi P, Contino E, Serafinelli E, Novario R, Chiaranda M. Accuracy of Critical Care Pain Observation Tool and Behavioral Pain Scale to assess pain in critically ill conscious and unconscious patients: prospective, observational study. J Intensive Care. 2016;4:68.
16. Gélinas C. Pain assessment in the critically ill adult: recent evidence and new trends. Intensive Crit Care Nurs. 2016;34:1-11.
17. Chanques G, Pohlman A, Kress JP, Molinari N, de Jong A, Jaber S, et al. Psychometric comparison of three behavioural scales for the assessment of pain in critically ill patients unable to self-report. Crit Care. 2014;18(5):R160.
18. Khanna P, Pandey RK, Chandralekha C, Sharma A, Pangasa N. Comparison between critical-care pain observation tool and physiologic indicators for pain assessment in the critically ill, mechanically ventilated adult patients. Saudi J Anaesth. 2018;12(3):384-8.
19. Varndell W, Fry M, Elliott D. A systematic review of observational pain assessment instruments for use with non-verbal intubated critically ill adult patients in the emergency department: an assessment of their suitability and psychometric properties. J Clin Nurs. 2017;26(1-2):7-32.

20. Safikhani S, Gries KS, Trudeau JJ, Reasner D, Rüdell K, Coons SJ, et al. Response scale selection in adult pain measures: results from a literature review. J Patient Rep Outcomes. 2018;2:40.
21. Von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. Lancet. 2007;370(9596):1453-7.
22. Hartrick CT, Kovan JP, Shapiro S. The numeric rating scale for clinical pain measurement: a ratio measure? Pain Pract. 2003;3(4):310-6.
23. Garra G, Singer AJ, Taira BR, Chohan J, Cardoz H, Chisena E, et al. Validation of the Wong-Baker FACES pain rating scale in pediatric emergency department patients. Acad Emerg Med. 2010;17(1):50-4.
24. Gélinas C, Fillion L, Puntillo KA, Viens C, Fortier M. Validation of the critical-care pain observation tool in adult patients. Am J Crit Care. 2006;15(4):420-7.
25. Zhai Y, Cai S, Zhang Y. The diagnostic accuracy of critical care pain observation tool (CPOT) in ICU patients: a systematic review and meta-analysis. J Pain Symptom Manage. 2020;60(4):847-56. e13.
26. Odhner M, Wegman D, Freeland N, Steinmetz A, Ingersoll GL. Assessing pain control in nonverbal critically ill adults. Dimens Crit Care Nurs. 2003;22(6):260-7.
27. McGuire DB, Kaiser KS, Haisfield-Wolfe ME, Iyamu I. Pain assessment in noncommunicative adult palliative care patients. Nurs Clin North Am. 2016;51(3):397-431.
28. Lim WH, Woods N, Lamaro VP. Trends and outcomes of ruptured ovarian cysts. Postgrad Med J. 2022;98(1161):e9.
29. Mehta H. Abdominal pain. In: Clinical Pathways in Emergency Medicine: Springer; 2016. p. 329-45.
30. Pothiawala S, Gogna A. Early diagnosis of bowel obstruction and strangulation by computed tomography in emergency department. World J Emerg Med. 2012;3(3):227.
31. Shirai T, Mori M, Uotani T, Chida K. Gastrointestinal disorders in anaphylaxis. Intern Med. 2007;46(6):315-6.
32. Hajian-Tilaki K. Sample size estimation in diagnostic test studies of biomedical informatics. J Biomed Inform. 2014;48:193-204.
33. Zhou Y, Petpichetchian W, Kitrungrote L. Psychometric properties of pain intensity scales comparing among postoperative adult patients, elderly patients without and with mild cognitive impairment in China. Int J Nurs Stud. 2011;48(4):449-57.
34. Boring BL, Walsh KT, Nanavaty N, Ng BW, Mathur VA. How and why patient concerns influence pain reporting: a qualitative analysis of personal accounts and perceptions of others' use of numerical pain scales. Front Psychol. 2021;12:663890.
35. Xu KT, Morris JE, Piel C. The Utility of Pain Scale to Assess Verifiable vs Non-Verifiable Pain in United States Emergency Departments. West J Emerg Med. 2021;22(2):156-62.
36. Haefeli M, Elfering A. Pain assessment. Eur Spine J. 2006;15(Suppl 1):S17-S24.
37. Wideman TH, Edwards RR, Walton DM, Martel MO, Hudon A, Seminowicz DA. The Multimodal Assessment Model of Pain: A Novel Framework for Further Integrating the Subjective Pain Experience Within Research and Practice. Clin J Pain. 2019;35(3):212-21.
38. Thong IS, Jensen MP, Miró J, Tan G. The validity of pain intensity measures: what do the NRS, VAS, VRS, and FPS-R measure? Scand J Pain. 2018;18(1):99-107.
39. Yam MF, Loh YC, Tan CS, Khadijah Adam S, Abdul Manan N, Basir R. General pathways of pain sensation and the major neurotransmitters involved in pain regulation. Int J Mol Sci. 2018;19(8):2164.
40. Topolovec-Vranic J, Gelinas C, Li Y, Pollmann-Mudryj MA, Innis J, McFarlan A, et al. Validation and evaluation of two observational pain assessment tools in a trauma and neurosurgical intensive care unit. Pain Res Manag. 2013;18(6):e107-e14.
41. Echegaray-Benites C, Kapoustina O, Gélinas C. Validation of the use of the Critical-Care Pain Observation Tool (CPOT) with brain surgery patients in the neurosurgical intensive care unit. Intensive Crit Care Nurs. 2014;30(5):257-65.
42. Pudas-Tähkä S-M, Salanterä S. Reliability of three linguistically and culturally validated pain assessment tools for sedated ICU patients by ICU nurses in Finland. Scand J Pain. 2018;18(2):165-73.
43. Klein C, Caumo W, Gélinas C, Patines V, Pilger T, Lopes A, et al. Validation of two pain assessment tools using a standardized nociceptive stimulation in critically ill adults. J Pain Symptom Manage. 2018;56(4):594-601.

Table 1: Comparing the baseline characteristics of included patients regarding the critical diagnosis and need for hospital admission

Characteristics	Critical diagnosis		p-value	Hospital admission		p-value
	Yes (n=38)	No (n=226)		Yes (n=65)	No (n=199)	
Age (years)						
Mean ± SD	47.3±16.0	47.2±19.9	0.96	51.5±17.0	45.8±20.0	0.04
Sex, n (%)						
Male	13 (34.2)	127 (56.2)	0.01	26 (40.0)	114 (57.3)	0.02
Ethnicity, n (%)						
Thai	35 (92.1)	208 (92.0)	0.29	57 (87.7)	186 (93.5)	0.08
Minority	1 (0.6)	1 (0.4)		2 (3.1)	0 (0.0)	
Chinese	1 (2.6)	2 (0.9)		1 (1.5)	2 (1.0)	
Others	1 (2.6)	15 (6.6)		5 (7.7)	11 (5.5)	
Time of arrival, n (%)						
Day (08:01-16:00)	19 (50.0)	77 (34.2)	0.17	28 (43.1)	68 (34.3)	0.41
Evening (16:01-24:00)	15 (39.5)	120 (53.3)		29 (44.6)	106 (53.5)	
Night (00:01-08:00)	4 (10.5)	28 (12.4)		8 (12.3)	24 (12.1)	
Day of visit, n (%)						
Weekday	31 (81.6)	162 (71.7)	0.20	50 (76.9)	143 (71.9)	0.42
Weekend	7 (18.4)	64 (28.3)		15 (23.1)	56 (28.1)	
Location of pain, n (%)						
Epigastrium	20 (52.6)	96 (43.5)	0.42	31 (47.7)	85 (42.7)	0.09
Right Upper Quadrant	4 (10.5)	17 (7.5)		8(12.3)	13 (6.5)	
Right Lower Quadrant	3 (7.9)	17 (7.5)		8(12.3)	12 (6.0)	
Suprapubic/pelvic	1 (2.6)	8 (3.5)		8 (4.0)	8 (4.0)	
Left Upper Quadrant	1(2.6)	16 (7.1)		16 (8.0)	16 (8.0)	
Left Lower Quadrant	2 (5.3)	41 (18.1)		37 (18.6)	37 (18.6)	
Generalized	6 (15.8)	21 (9.3)		19 (9.6)	19 (9.6)	
Periumbilical	1 (2.63)	10 (4.4)		9 (4.5)	9 (4.5)	
Characteristics of pain, n (%)						
Dull aching	20 (52.6)	64 (28.3)	0.01	31 (47.7)	53 (26.6)	0.001
Throbbing/stabbing	6 (15.8)	26 (11.5)		11 (16.9)	21 (10.6)	
Cramping	5 (13.2)	95 (42.0)		12 (18.5)	88 (44.2)	
Burning	3 (7.9)	21 (9.3)		3 (4.6)	21 (10.6)	
Others	4 (10.5)	20 (8.6)		8 (12.3)	16 (8.0)	
Duration of pain, hours						
Median (IQR)	8 (2-24)	9 (3-24)	0.97	11 (3-48)	8 (2-24)	0.13
Vital signs						
Systolic blood pressure, mmHg	133.2±29.6	133.7±25.4	0.90	133.4±29.2	133.7±25.0	0.95
Diastolic blood pressure, mmHg	82.2±21.6	81.0±17.3	0.71	81.1±19.7	81.2±17.4	0.98
Pulse rate, bpm (mean ± SD)	90.7±21.2	88.6±19.3	0.53	91.1±19.3	88.2±19.6	0.29
Respiratory rate, per minute	21.3±5.6	19.5±2.7	0.002	21.2±5.0	19.3±2.4	<0.001
Oxygen saturation, %	97.6±3.4	98.2±1.5	0.07	97.5±2.8	98.3±1.4	0.002

Data are presented as mean ± standard deviation (SD), median (IQR), or frequency (%).
IQR: interquartile ranges; SD: standard deviation.

Table 2: Comparing the median pain scores between cases with and without abdominal pain with critical diagnosis as well as those with and without need for hospital admission

Pain scales	Total (n=264)	Critical diagnosis		p-value	Hospital admission		p-value
		Yes (n=38)	No (n=226)		Yes (n=65)	No (n=199)	
Numerical rating scale (0- 10)†							
Median (IQR)	8 (7-10)	8 (8 -10)	8 (7 - 10)	0.50	8 (8 - 10)	8 (7 - 10)	0.18
Face pain scale (0- 10)†							
Median (IQR)	8 (6 - 8)	8 (6 - 8)	8 (6 - 8)	0.33	8 (6 - 8)	8 (6 - 8)	0.28
Critical-care pain observation tool (0- 8)†							
Median (IQR)	3 (1 - 4)	3 (2 - 4)	3 (1 - 4)	0.07	3 (1 - 4)	3 (0 - 4)	0.09
Non-verbal pain scale (0- 10)†							
Median (IQR)	3 (2 - 4)	4 (3 - 5)	3 (1 - 4)	0.02	4 (2 - 5)	3 (1 - 4)	0.07

†Range of score. IQR: interquartile range.

Table 3: Spearman's rank correlation coefficient between each two pain scales regarding the presence of abdominal pain with critical diagnosis

	NRS	FPS	CCOT	NVPS
NRS		0.656 (0.581 – 0.719)	0.539 (0.448 – 0.620)	0.505 (0.409 – 0.590)
FPS	0.656 (0.581 – 0.719)		0.690 (0.621 – 0.748)	0.643 (0.566 – 0.709)
CPOT	0.539 (0.448 – 0.620)	0.690 (0.621 – 0.748)		0.818 (0.774 – 0.854)
NVPS	0.505 (0.409 – 0.590)	0.643 (0.566 – 0.709)	0.818 (0.774 – 0.854)	

Data are presented with 95% confidence interval. NRS: Numerical rating scale; FPS: Face pain scale;
CPOT: Critical-care pain observation tool; NVPS: Non-verbal pain scale.

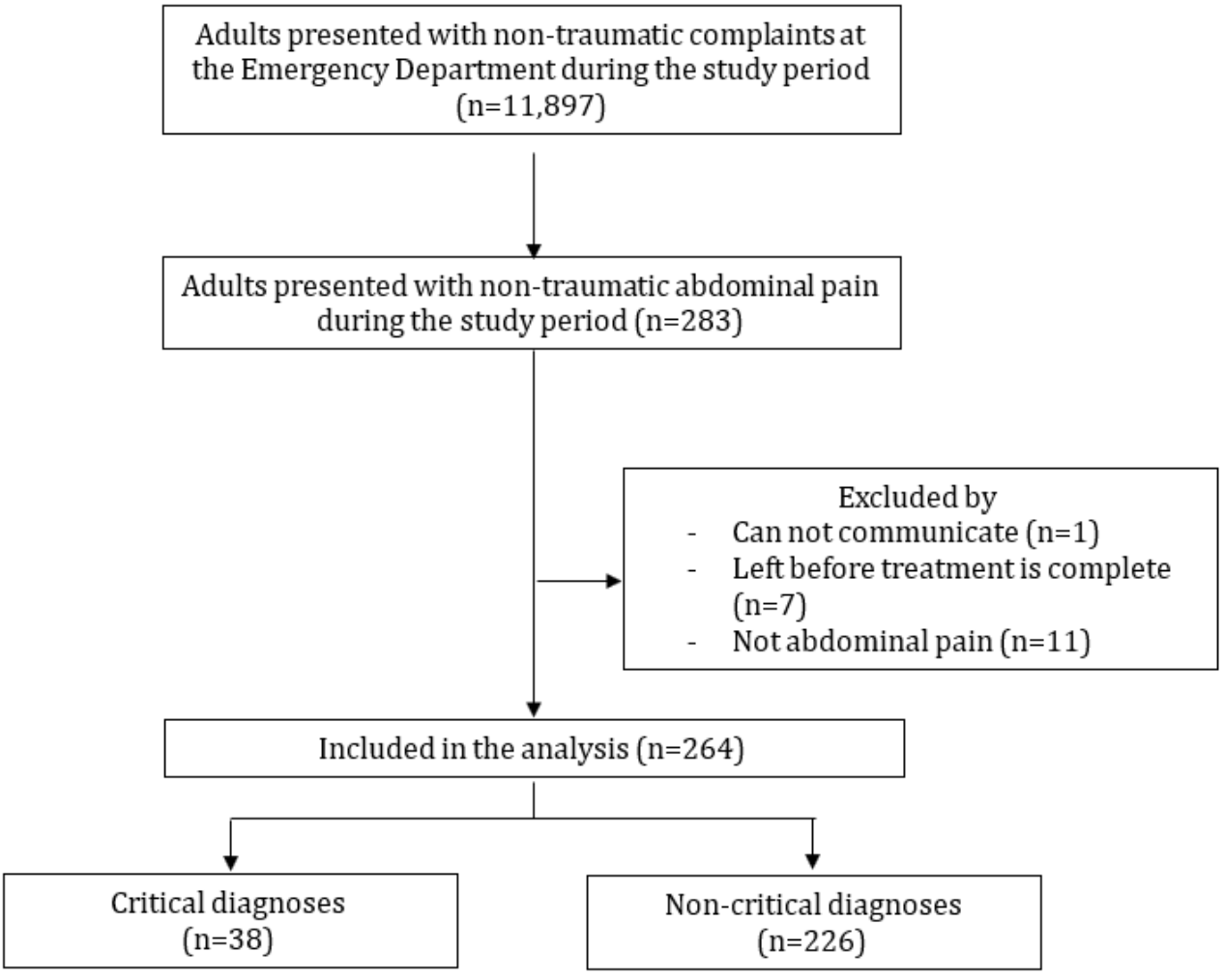

Figure 1: The study flow diagram.

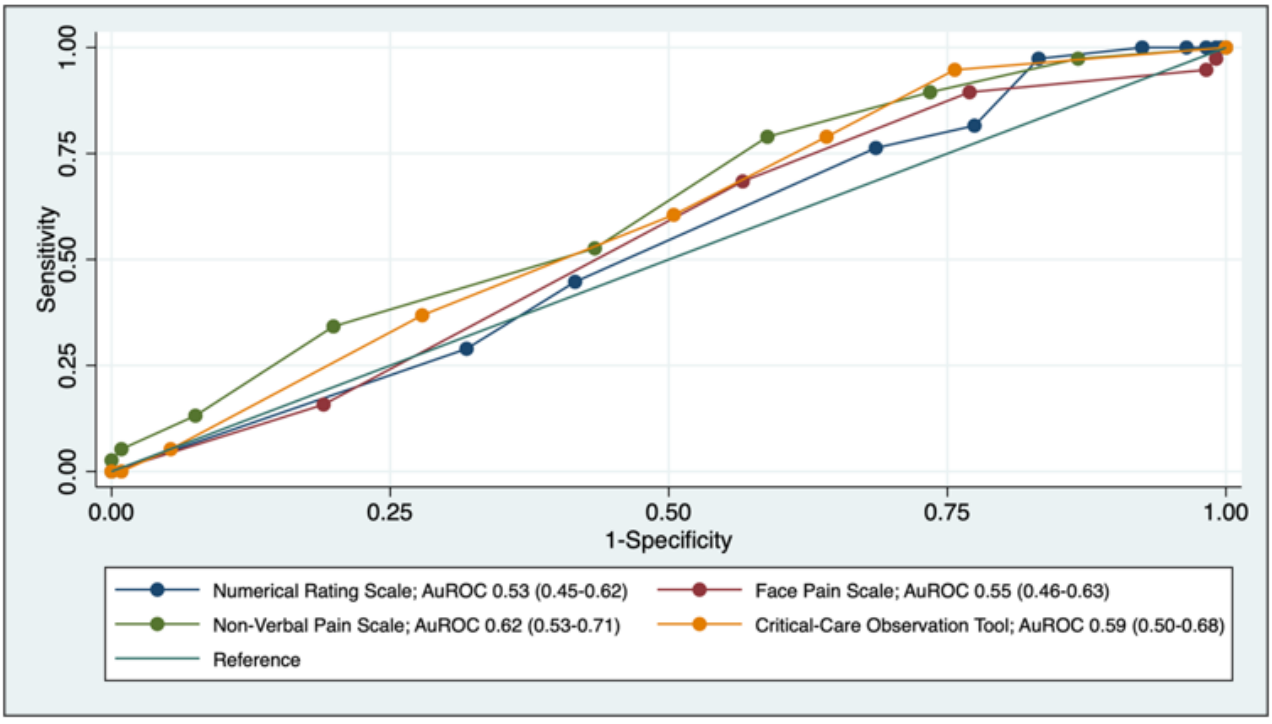

Figure 2: Receiver operating characteristic curves of the Numerical Rating Scale, Face Pain Scale, Non-Verbal Pain Scale, and Critical-Care Observational Tool for predicting the critical diagnoses in adults who presented to the Emergency Department with non-traumatic abdominal pain.